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COMMENTARY

Data extraction methods: an analysis of internal reporting discrepancies in single manuscripts and practical advice

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Abstract

Background: Data extraction from reports about experimental or observational studies is a crucial methodological step informing evidence syntheses, such as systematic reviews (SRs) and overviews of SRs. Reporting discrepancies were defined as pairs of statements that could not both be true. Authors of SRs and overviews of SRs can encounter reporting discrepancies among multiple sources when extracting data—a manuscript and a conference abstract, and a manuscript and a clinical trial registry. However, these discrepancies can also be found within a single manuscript published in a scientific journal.

Objectives: Hereby, we describe examples of internal reporting discrepancies that can be found in a single source, with the aim of raising awareness among authors of SRs and overviews of SRs about such potential methodological issues.

Conclusions: Authors of SRs and overviews of SRs should check whether the same information is reported in multiple places within a study and compare that information. Independent data extraction by two reviewers increases the chance of finding discrepancies, if they exist. We provide advice on how to deal with different types of discordances and how to report such discordances when conducting SRs and overviews of SRs.

Keywords: Data; Data extraction; Systematic reviews; Discrepancies; Reporting; Errors

1. Introduction

Data extraction from reports about experimental or observational studies is a crucial methodological step informing evidence syntheses, such as systematic reviews (SRs) and overviews of SRs. Studies about data extraction for SRs have warned about possibility of extraction errors and high probability that two authors may extract different data [1,2]. The term ‘‘extraction errors’’ refers both to subjective errors that are responsibility of reviewers (i.e., review authors extracted erroneous data) and objective errors within the manuscript that are responsibility of the primary study authors (i.e., different data reported in different sections within a manuscript). It has been reported that objective errors in primary studies are frequent [3,4]. These errors pose challenges to readers, reviewers, guideline developers, and can propagate into SRs.

A recently published SR about data extraction errors by Mathes et al. [5] indicated that extraction errors often have influence on the effect estimates. As a crucial element of systematic methodology, it has been recommended that two reviewers should conduct data extraction independently, or that one reviewer should do data extraction and another one verify the extraction [6,7]. The former should

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What is new?

Key findings

- Discrepancies can be found within a single research manuscript; these internal reporting discrepancies may negatively influence evidence synthesis.
- Internal reporting discrepancies may occur in various parts of the manuscript.

What this adds to what was known?

- It has been already indicated that research publications have errors, but implications of internal reporting discrepancies for evidence synthesis, such as systematic reviews and overviews of systematic reviews, have not been discussed before.

What is the implication and what should change now?

- Authors of evidence synthesis should be aware of the possibility of internal reporting discrepancies, check for multiple reports of the same information, contact authors to resolve such discrepancies, and transparently report them.
- Interventions for reducing internal reporting discrepancies would be welcome.

be the preferred method because Buscemi et al. [8] showed that the risk of extraction errors is significantly lower with two independent extractions compared to single extraction verified by another reviewer.

Discrepancies were defined as "pairs of statements that could not both be true" [9]. Authors of SRs and overviews of SRs can encounter reporting discrepancies among multiple sources when extracting data: between two manuscripts that describe the same study, and between a published manuscript and a conference abstract [10−12], and between trial registry entries and published manuscripts [13]. Attention to this has also been called in the new version (version 6) of the Cochrane Handbook for Reviews of Interventions, and its Chapter 5, where authors are warned that discrepancies may occur across multiple sources, and that authors should have a plan for resolving discrepancies [14].

However, as Cole et al. [15] have shown, discrepancies can also be found within a single manuscript published in a scientific journal. Even multiple peer reviews, copyediting, and revision of galley proof by original authors do not completely protect against the hazard of making one or more errors. The chance of finding discrepancies within a single manuscript is particularly high in complex SR, which often requires analysis of a large quantity of data from the same report/manuscript [16].

Cole et al. [15] have shown that it is difficult for readers of research manuscripts to notice discrepancies: in their study, they included 343 readers and found that 95.3% of discrepancies were missed. Reviewers of primary studies are, instead, a selected group of readers of primary articles: they carefully examine study data, extracting them in structured formats. This task facilitates spotting errors and discrepancies. If two reviewers are involved in data extraction, either independently or as verification, there is higher likelihood that errors and discrepancies will be found.

Hereby, we describe examples of objective errors and internal reporting discrepancies that SR and overviews of SRs authors can find within a single published manuscript, with the aim of raising awareness about such potential methodological issues. We also provide advice on how to deal with different types of discrepancies and how to report them when conducting SRs and overviews of SRs.

2. Possible types of internal reporting discrepancies

Internal reporting discrepancies occur when different data are reported in different sections within the same manuscript. In our experience, we identified 5 possible types of internal reporting discrepancies: abstract-text discrepancies, within-the-full-text discrepancies, text-figure discrepancies, text-table discrepancies, and discrepancies in multiple sections of the same manuscript. We reported in Table 1 some examples of each type of discrepancies.

Some of these discrepancies can be judged as trivial, such as differences encompassing second digit after the decimal place. However, other discrepancies, such as differences in study participants or number of included studies, can be relevant. They can have implication on key dimensions, such as generalizability of findings, or on key methods, such as the assumed degree of freedom to estimate heterogeneity.

3. Take-home message: systematic review authors should be aware of potential internal reporting discrepancies

Examples shown in this manuscript were discovered by a systematic approach because two independent data extractors found certain information in different places of the same manuscript. These represent an infinitesimal fraction of all published reviews and included errors within reviews. It is important that the meaning of systematic in "systematic reviews" is extended also to data checking, on top of search strategies and risk of bias assessment. If this approach to discrepancy becomes more frequent and consistent across review teams, discrepancies will not

Table 1. Possible types of internal reporting discrepancies

Type of discrepancies	Description	Examples

Abstract-text discrepancies	Discrepancies between the abstract and the full-text of a manuscript	• In an MA [17], there was a discrepancy regarding the databases that were searched, with the abstract being more detailed than the full text of the manuscript:
		  • The abstract reported "MEDLINE and the Cochrane Central Register of Controlled Trials databases (1966 to March 2005)."
		  • In the text, it was stated "A comprehensive MEDLINE database search using Ovid software (Ovid Technologies Inc, New York, NY) was performed to find human studies published in the English language between 1966 and March 2005."
		• In an MA [18], there was a minor numerical discrepancy regarding the CI of the effect size of aspirin in the prevention of stroke:
		  • In the abstract, it was stated that the risk ratio was "0.84; 95% CI, 0.64–1.11."
		  • In the full text and Figure 2, it was reported that the risk ratio was "0.84, 95% CI 0.63–1.11"
		• In an MA [19], there was a discrepancy in the number of included patients:
		  • In the abstract, it was stated "six trials consisting of 7,374 patients with diabetes."
		  • The sum of patients included in the six trials reported in Table 2 is 7,907.
		• In an MA [20], there was a discrepancy in the number of included RCTs:
		  • In the abstract, it was stated "nine RCTs with moderate to high methodological quality contributed data to the analyses."
		  • In the flow chart (Figure 1) and in the text, it was reported that eight RCTs were included in the MA.

Within-the-full-text discrepancies	Discrepancies in different parts of the body of a manuscript	• In an RCT [21], there was a discrepancy in the number of patients who discontinued treatment due to AEs:
		  • In the text (p 75), it was stated "The reasons for discontinuation included the following: AEs in 13 (10.3%) and 12 (9.8%) celecoxib- and diclofenac-treated patients, respectively."
		  • In the text (p 78), it was stated "Similar numbers of patients in each group discontinued the study medication because of treatment-related AEs (celecoxib, 17/125 [13.6%]; diclofenac, 16/123 [13.0%])."
		  • Furthermore, Figure 1 showed that the number of patients who discontinued because of AEs was 13/126 in the celecoxib group (with a note that "One randomized patient did not receive any study medication," therefore 13/125) and 12/123 in the diclofenac group.

Text-figure discrepancies	Discrepancies between a figure and the full-text of a manuscript	• In an MA [20], there were several discrepancies in the effect size of aspirin in the prevention of mortality, myocardial infarction, and ischemic stroke in the overall population and in patients with and without diabetes:
		  • In the text, it was reported that the relative risk "for the outcomes of mortality, myocardial infarction, and ischemic stroke were 0.93 (95% CI 0.85–1.03; I2 0%), 0.79 (0.66–0.95; I2 63%), and 0.73 (0.43–1.22; I2 39%), respectively. Estimates among patients with diabetes were 0.97 (0.87–1.08; I2 0%), 0.86 (0.67–1.11; I2 53%), and 0.62 (0.31–1.24; I2 67%), respectively. The corresponding estimates among patients without diabetes were 0.87 (0.75–1.02; I2 0%), 0.72 (0.55–0.95; I2 70%), and 0.89 (0.41–1.94; I2 0%), respectively."
		  • In Figure 1, it was reported that the relative risk (95% CI) for mortality was 0.75 (0.60- 0.93) in the overall population, 0.81 (0.55–1.19) in patients with diabetes, 0.72 (0.55–0.94) in patients without diabetes. The relative risk for myocardial infarction was 0.73 (0.43–1.22), 0.62 (0.29–1.30), 0.89 (0.41–1.94), respectively. The relative risk for ischemic stroke was 0.93 (0.83–1.05), 1.02 (0.85–1.21), 0.87 (0.75–1.02), respectively. A corrigendum to this figure was recently issued [22].

(*Continued*)

Table 1. Continued

Type of discrepancies	Description	Examples
		• In an RCT [23], there was a discrepancy regarding the number of randomized patients: • In the text, it was stated "Of the 22 patients included in the RCT, four were excluded for mobility assessments due to inability to understand instructions ($n = 2$) or due to missing data because measurements could not be performed due to logistical reasons ($n = 2$; Figure 1). Hence, 18 patients were included in the mobility assessments." • The flow diagram (Figure 1) reported "Assessed for eligibility $N = 22$" and "randomized $N = 18$." The discrepancy in randomized patients encompasses a difference of almost 20% between the two figures (18 or 22 randomized patients).
Text-table discrepancies	Discrepancies between a table and the full text of a manuscript	• In an MA [24], there was a discrepancy regarding the number of included participants: • In Table 1, the sum of participants was 500,473. • In the text, it was stated that "eight case-control studies with 21,356 cases and 187,037 controls and five cohort studies incorporating 294,377 participants were included," which would sum up to 502,770 participants. Although this difference in absolute terms is impressive (2,297 participants), in relative terms, the difference is only 0.5%.
Multiple discrepancies	Discrepancies in multiple sections of the same manuscript	• In an RCT [25], there were discrepancies regarding the number of included patients overall and in the different arms: • Abstract, Figure 1, Table 1, and Table 5 indicated that 502 patients were randomized into four groups: dabigatran 50 mg BID ($n = 105$), dabigatran 150 mg BID ($n = 166$), dabigatran 300 mg BID ($n = 161$), and warfarin ($n = 70$). • Tables 2 and 3 indicated that the number of patients in the different groups was dabigatran 50 mg BID ($n = 107$), dabigatran 150 mg BID ($n = 169$), dabigatran 300 mg BID ($n = 169$), and warfarin ($n = 70$), which would sum up to 515 patients.

Abbreviations: AE, adverse event, BID, twice daily, CI, confidence interval, MA, meta-analysis, RCT, randomized controlled trial.

disappear, but at least they will not extend to secondary publications. It is highly likely that some of these discrepancies would not be found if the two reviewers looked for the information in the same place or if the reviewers did not check the entire manuscript. SR authors doing extraction should read the entire article because discrepancies may be found anywhere and not just in manuscript sections where data are typically found. Authors of SRs and overviews of SRs should also check whether data of interest are presented in multiple places in a manuscript of interest (abstract-text, different paragraphs of the text, text-figures/tables) and contrast the same information reported in multiple sections.

4. What should systematic review authors do in case of internal reporting discrepancies?

Internal reporting discrepancies can have implications at the review level, which requires solutions to overcome challenges from the perspective of a reviewer.

Some of the discrepancies we encountered while conducting SRs and overviews of SRs were minor and unlikely to change the direction of results in an SR or overviews of SRs, or the overall quality of evidence. However, some discrepancies were major, potentially reverting results in a meta-analysis or causing complete misinterpretation of results. It has also been previously emphasized that discrepancies can be a sign of deeply problematic studies, warranting further attention and verification [15]. The judgment of the relevance of discrepancies should be always collegial, involving more reviewers. The team should consider the interplay between the identified discrepancy and the results or other important dimensions of the review, such as risk of bias.

If authors extracting data from studies find discrepancies, they should attempt to contact corresponding authors of those studies to ask for clarification. If corresponding authors do not respond, the next step should be to try to contact all the authors of the study because this can increase the likelihood to obtain a response. It would be also valuable to copy the journal editor on this communication with author(s).

If the efforts to contact the study authors fail, authors of SR and overviews of SRs can choose to use several approaches, depending on the severity of the reporting discrepancy. If the reporting discrepancies are minor, the authors can include one set of data, with accompanying

explanation about their choice. A second option is doing a sensitivity analysis to check whether inclusion of the other set of data could impact on the overall results, or a sensitivity without the involved data set. If the discrepancy has limited implications, we advise against an exclusion ''without appeal'' of the study, as this would be a disproportionate solution.

If the discrepancy is severe and choosing one data set over another would change direction of results, then it should be excluded from the main analysis and, eventually, included in a sensitivity analysis. For example, as in Cochrane reviews, a study can be classified as ''awaiting classification'' until the reporting discrepancy is resolved.

Irrespective of types of discrepancy, SR authors should always clearly describe what type of reporting discrepancy was found and what the implications were. In addition, authors of SRs and overviews of SRs should clearly report whom they tried to contact and how.

We summarized our suggestions for SR authors on how to address internal reporting discrepancies in Table 2.

5. How to deal with internal reporting discrepancies in the literature?

Internal reporting discrepancies can have also implications at the literature level, requiring solutions to signal, and potentially solve discrepancies.

Table 2. Suggestions for systematic review authors on how to address internal reporting discrepancies

SR authors should read the entire manuscript, check whether the same information is reported in multiple places within a manuscript, and compare that information
Two SR authors should conduct data extraction independently, to increase the likelihood of finding internal reporting discrepancies (if they exist)
If an internal reporting discrepancy is detected, a third SR author should be involved to confirm the presence of the discrepancy
The judgment of the relevance of internal reporting discrepancies should be always collegial, involving more SR authors
SR authors should attempt to contact the authors of studies with internal reporting discrepancies asking for clarification (eventually copying the journal editor in this communication)
If the internal reporting discrepancy is minor (e.g., unlikely to change the direction of results in an SR), SR authors can decide to include one of the two sets of data (with an accompanying explanation about their choice) and perform a sensitivity analysis (either including the other set of data or excluding the involved data set, to check the impact on the overall results)
If the internal reporting discrepancy is major (e.g., potentially reverting the results in a meta-analysis or causing complete misinterpretation of the results), the data set should be excluded from the main analysis (the study can be classified as ''awaiting classification'') and eventually included in a sensitivity analysis
SR authors should describe what type of internal reporting discrepancy was found, its implication, and their attempts to solve this discrepancy

Abbreviation: SR, systematic review.

Our experiences with spotting discrepancies and trying to solve them were that sometimes authors immediately indicated that there was indeed an error. Authors can be scrupulous, immediately notifying the journal the error and asking for a corrigendum. Other authors of manuscripts with discrepancies did not consider that a corrigendum was needed. Authors of SRs or overviews of SRs can also send a letter to the editor of the journal where the manuscript with discrepancies was found, indicating that there is a reporting discrepancy that should be clarified. It is in the interest of the research community to have access to publications without factual errors, and every effort to correct reporting discrepancies would be a valuable investment to increase the quality of the scientific literature.

Editors, peer reviewers, and manuscript authors have a crucial role in trying to prevent the appearance of internal reporting discrepancies. Peer reviewers, editorial staff and journal publishers should also check for potential discrepancy if certain information or data appear in multiple places in the manuscript. One potential solution is to create a checklist for copy editors and editorial staff, regarding multiple mentions of the same information and whether some discrepancies were spotted.

Some of the discrepancies we found, according to the contacted authors, were not the fault of authors, but happened after the acceptance of the manuscript. Corresponding authors are usually prompted by publishers to carefully review galley proofs to make sure that there are no errors [26]. This manuscript can also be a reminder to authors to carefully review the galley proofs before study publication, to check whether the same information is present in multiple places in the manuscript and whether there are any discrepancies that can still be corrected before final manuscript publication.

Journals may inadvertently contribute to discrepancies. Changes made by journal staff are not always clearly highlighted in the galley proof, making more difficult for the authors to spot potential errors. Some editors edit article page proofs without final approval by authors, which may lead to some discrepancies. The authors should always be given a chance to verify and approve editorial changes.

6. Conclusion

It has been already emphasized that most manuscripts published in the most important medical journals have errors [3]. The aim of this manuscript was not to simply repeat that errors can be found in a published manuscript but to raise awareness among authors of SRs and overview of SRs—and other types of studies which use data extraction from published reports about other studies—that discrepancies within a single manuscript can be more common than expected and that sometimes those discrepancies can have major consequences for conclusions of SRs and overviews of SRs. The importance of meticulous

editorial and peer-review process, as well as galley proof checking, should also be highlighted as measures for preventing objective errors. As Cole et al. [15] have observed, ''Even minor discrepancies should not be neglected, as they may be the tip of an error iceberg''.

This manuscript included selected examples of discrepancies based on authors' experiences. By engagement of the wider research community, the next step could be to develop a taxonomy of discrepancies that SR and overview of SR authors may encounter. Such taxonomy could be used as a checklist or a decision tool for review authors and to help them to evaluate the nature and the impact of discrepancies.

CRediT authorship contribution statement

Livia Puljak: Conceptualization, Methodology, Writing - original draft, Writing - review & editing. **Nicoletta Riva:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing. **Elena Parmelli:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing. **Marien González-Lorenzo:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing. **Lorenzo Moja:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing. **Dawid Pieper:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing.

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